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Original Article

Randomized control trial of non-vascularized fibular and iliac crest graft for mandibular reconstruction

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ABSTRACT

Background: Mandibular reconstruction of segmental defects caused by trauma or tumor excision is a challenge despite numerous advances in surgical and fixation techniques. Bone grafts from fibula or iliac crest are most frequently used to reconstruct mandible.

Methods: A prospective randomized study was performed in 20 patients with benign mandibular pathology, to compare non-vascularized fibular and iliac crest bone graft for graft success, improvement in esthetics and function, and any associated donor site complications.

Results: No significant difference in graft success, esthetics, function, or donor site complication were found between the two groups. Function improvement was significantly higher in fibula group as compared to iliac crest. An interesting finding of positive association between length of defect and complication was seen irrespective of the graft used, implying that patients with larger defects had higher complication rates.

Conclusion: Non-vascularized fibular bone graft is as better as iliac crest for reconstruction of mandibular defects of optimal length.

Keywords: *Fibula, Iliac crest, Non-vascular, Mandibular, Reconstruction*

INTRODUCTION

Reconstruction of mandibular defects after trauma or tumor resection is one of the most challenging problems faced by any reconstructive surgeon. The mandible plays a major role in airway protection and support of tongue, lower dentition, and muscles of floor of mouth, thereby permitting mastication, articulation, deglutition, and respiration. It also defines the contour of the lower third of the face. Interruption of mandibular continuity, therefore, produces both a cosmetic and functional deformity.

Loss of mandibular continuity results in deviation of the mandible toward the resected side due to the unopposed pull of remaining muscles of mastication, soft tissue contracture and scar formation. There is limited range of motion when attempting lateral and protrusive movements of the jaw. Contralateral muscles of mastication allow a return to midline on opening or closing. Additionally, there are problems of malocclusion and proprioception.

When undertaking mandibular reconstruction, the restoration of bony continuity should not be considered as the only measure of success. The functions of chewing, swallowing, speech articulation, and oral competence must also be addressed. The ultimate goal of mandibular reconstruction is to return to previous state of function. In order to achieve this goal, attempt must be made to restore bony continuity and facial contour, maintain tongue mobility, restore sensation to the denervated areas and rehabilitate.

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MATERIAL & METHODS

Twenty patients, 14 males and 6 females, in the age group of 14–45 years, who visited our outpatient clinic for management of large benign mandibular pathology, were randomly allocated to two different groups each containing 10 patients, after institutional ethical approval of the study. Written informed consent was obtained from the enrolled subjects. In the experimental group (Group I), reconstruction was done using fibular bone graft (Figs. 1 and 2), while in the control group (Group II) iliac crest bone graft was used for mandibular reconstruction (Fig. 3). Mean age of the subjects was 26.89 years.

Patients were operated under general anesthesia using naso-endotracheal intubations. Strict asepsis was followed. In this study, operating sites were exposed through both intraoral and extraoral approach. Blunt dissection was done to expose the lesion. Bony lesion was resected and temporary inter-maxillary fixation was done to achieve occlusion. A sufficient length of plate, with 3 holes extending onto sound bone on either side, was selected, contoured and fixed with screws at the lower border of mandible to avoid injury to the inferior alveolar nerve and tooth roots. Simultaneous harvest of either of the graft was done. Fibula was harvested using 'Henry's Approach' in experimental group. Iliac crest was harvested using standard anterior approach methodology and technique for the control group. The size and shape of the grafts harvested were adjusted according to the size and shape of the defect. Inter-maxillary fixation was released, occlusion was checked and site was closed.

Patients were placed on intravenous fluid on the day of the surgery and liquid diet for the first postoperative week. The patients were advised to maintain good oral hygiene. Assessment of the patients was done for improvement in esthetics and function, graft success and donor site complications at 1, 3, 6, and 24 weeks of follow up, till 6 months.

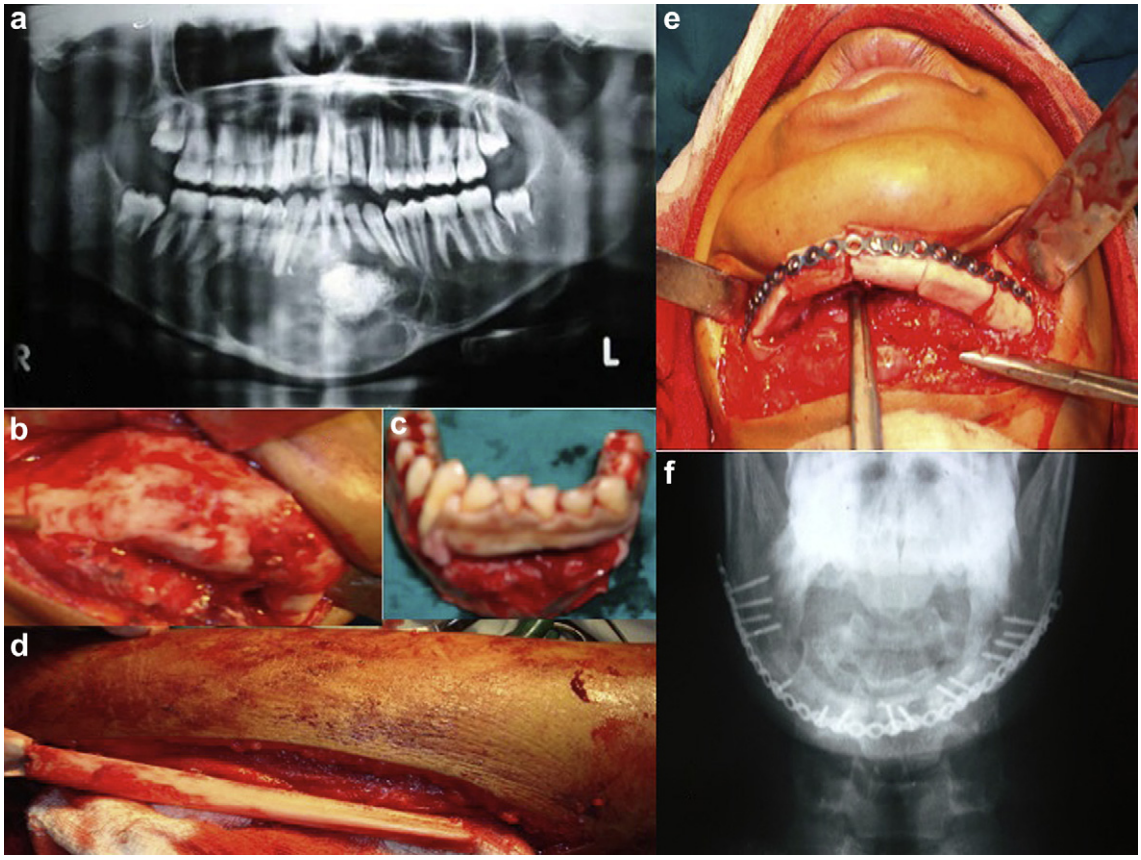

Fig. 1 a) Orthopantomogram showing radiolucent lesion in anterior mandible, b) intraoperative picture exposing same lesion c) excised surgical specimen d) harvested non-vascularized fibular graft e) mandibular reconstruction using fibula bone graft f) PA view X-ray mandible showing mandibular reconstruction.

Fig. 2 Preoperative and postoperative photograph of same patient.

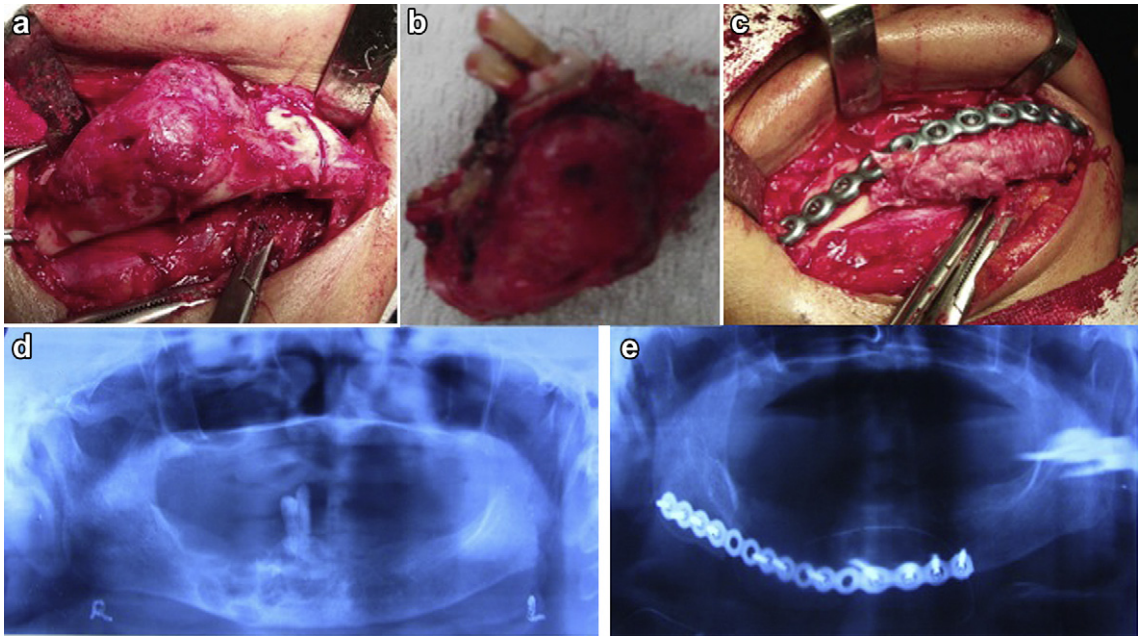

Fig. 3 a) Intraoperative picture exposing bony lesion b) excised surgical specimen c) mandibular reconstruction using iliac crest bone graft d) orthopantomogram showing radiolucent lesion in anterior mandible, e) orthopantomogram showing reconstructed mandible.

RESULTS

Among 20 patients enrolled in the study, maximum *i.e.* 10 (50%) were in the age group of 21−30 years, 5 (25%) were less than 20, and 5 (25%) were above 30. The mean age of the subjects was 26.89 ± 9.40 years with a minimum age of 14 years and maximum 45 years. There were 6 females (30%) and 14 (70%) males. The male to female ratio of the subjects was 2.33:1 Tables 1 and 2.

Ameloblastoma was the main diagnostic entity in both the groups. Odontogenic myxofibroma, osteoblastoma, cemento-ossifying fibroma, odontogenic keratocyst and osteomyelitis were the other diagnostic entities encountered in 1 case each. Statistically, there was no significant difference between two groups ($p = 0.279$) Table 3.

At first week, 1 (10%) patient in Group I and 2 (20%) of Group II patients showed function improvement ($p = 0.531$). By 3rd week, 6 patients in each group and by 6th week, all patients (100%) in Group I and 8 (80%) of Group II showed function improvement ($p = 0.136$). 12th week onwards, all patients showed improvement in function. Statistically, there was no significant difference between the two groups at any time interval ($p > 0.05$) Table 4.

The outcome was esthetically acceptable in 7 patients of Group I (70%) and 6 patients (60%) of Group II respectively, showing no statistically significant difference between two groups ($p = 0.639$). By 3rd week, it was acceptable in all the cases (100%) of Group I and 8 (80%) cases of Group II, once again showing no significant difference between the two groups ($p = 0.136$). By 6th week, all the patients (100%) in both groups showed esthetically acceptable results Table 4.

Pain score was 5.60 ± 0.84, 2.40 ± 0.97, 0.70 ± 0.68, 0.10 ± 0.31 and 0 ± 0 in Group I at 1, 3, 6, 12 and 24 weeks respectively whereas the corresponding scores in Group II were 5.30 ± 1.16, 2.50 ± 1.18, 0.70 ± 0.95, 0.10 ± 0.32 and 0.10 ± 0.32, showing no statistical significant difference between two groups at any time interval ($p > 0.05$) Table 4.

Infection was not seen in either group at 1 week. However at 3, 6, 12 and 24 weeks, infection was seen in 1 (10%), 3 (30%), 2 (20%) and 1 (10%) subjects in Group II whereas in Group I in none, 1 (10%), 5 (50%) and 1 (10%) patients respectively. Statistically, there was no significant difference between the two groups ($p > 0.05$). Antimicrobial therapy started after culture and sensitivity test, showed regression of the same in subsequent follow-ups Table 4.

Wound dehiscence was seen in 1 (10%) patient of Group II and no patient of Group I ($p = 0.357$) at 3 weeks. At 6 weeks it increased to 3 (30%) patients of Group I and 2 (20%) patients of Group II ($p = 0.305$). At 12th week, wound dehiscence was seen in 6 (60%) patients of Group I and 3 (30%) of Group II ($p = 0.178$). By 24th week it healed in most, while 1 (10%) of both groups still persisted with wound dehiscence Table 4.

Both groups showed that patients with larger size of defect had higher proportion of complications ($p = 0.010$ and $p = 0.027$) respectively, overall ($p = 0.008$) Table 5.

Table 1 Agewise distribution in both groups.

S No	Age Group (years)	Group I (fibula) N = 10 (%)	Group II (iliac crest) N = 10 (%)	Total N = 20 (%)
1	11−20	4 (40)	1 (10)	5 (25.6)
2	21−30	4 (40)	6 (60)	10 (50)
3	31−40	2 (20)	1 (10)	3 (15)
4	41−50	0 (0)	2 (20)	2 (10)

$x^2 = 4.533$ (df = 3): $p = 0.209$.

Table 2 Genderwise distribution in both groups.

S No	Gender	Group I (fibula) N = 10 (%)	Group II (iliac crest) N = 10 (%)	Total N = 20 (%)
1	Male	3 (30)	3 (30)	6 (30)
2	Female	7 (70)	7 (70)	14 (70)

$x^2 = 0$ (df = 1): $p = 1$.

Table 3 Diagnosis of lesions in both groups.

S No	Diagnosis	Group I (fibula) N = 10 (%)	Group II (iliac crest) N = 10 (%)
1	Odontogenic myxofibroma	2 (20)	0 (0)
2	Ameloblastoma	6 (60)	8 (80)
3	Osteoblastoma	1 (10)	0 (0)
4	Cemento-ossifying fibroma	1 (10)	0 (0)
5	Odontogenic keratocyst	0 (0)	1 (10)
6	Osteomyelitis	0 (0)	1 (10)

$x^2 = 6.286$ (df = 5): $p = 0.279$.

Table 4 Outcome variables for graft success.

S No	*Time duration (weeks)*	*Group I (fibula) N = 10 (%)*	*Group II (iliac crest) N = 10 (%)*		
Function improvement				x^2	"p"
1	1	1 (10)	2 (20)	0.392	0.531
2	3	6 (60)	6 (60)	0	1
3	6	10 (100)	8 (80)	2.222	0.136
4	12	10 (100)	10 (100)	–	–
5	24	10 (100)	10 (100)	–	–
Esthetic improvement				x^2	"p"
1	1	7 (70)	6 (60)	0.220	0.639
2	3	10 (100)	8 (80)	2.222	0.136
3	6	10 (100)	10 (100)	–	–
4	12	10 (100)	10 (100)	–	–
5	24	10 (100)	10 (100)	–	–
Pain (VAS)				*z*	"p"
1	1	5.60 ± 0.84	5.30 ± 1.16	−0.709	0.529
2	3	2.40 ± 0.97	2.50 ± 1.18	−0.167	0.912
3	6	0.70 ± 0.68	0.70 ± 0.95	−0.334	0.796
4	12	0.10 ± 0.31	0.10 ± 0.32	0	1
5	24	0.00 ± 0.0	0.10 ± 0.32	−1.000	0.739
Infection				x^2	"p"
1	1	0 (0)	0 (0)	–	–
2	3	0 (0)	1 (10)	1.053	0.305
3	6	1 (10)	3 (30)	1.250	0.263
4	12	5 (50)	2 (20)	1.978	0.160
5	24	1 (10)	1 (10)	0	1
Dehiscence				x^2	"p"
1	1	0 (0)	0 (0)	–	–
2	3	0 (0)	1 (10)	1.053	0.305
3	6	3 (30)	2 (20)	0.267	0.606
4	12	6 (60)	3 (30)	1.818	0.178
5	24	1 (10)	1 (10)	0	1

DISCUSSION

Several types of bone grafts have been used for mandibular reconstruction, including autogenous, homologous and xenogeneic grafts. Despite the popularity of alloplastic reconstructive materials, they present with a 60–80% failure rate. Xenograft differ in their potential to cause host-graft immunologic response. Autogenous grafts remain the standard choice as they provide viable and immune-compatible osteoblastic cells. Fibula and iliac crest are the available options of autogenous bone graft.

Table 5 Association of length of defect and complications.

S No	*Length of defect (cm)*	*Group I (fibula) N = 10 (%)*		*Group II (iliac crest) N = 10 (%)*		x^2	"p"
		No complication	*With complication*	*No complication*	*With complication*		
1	3–6	0	0	5	0	9.600	0.008
2	6–9	4	1	0	2		
3	> 9	0	5	1	2		
x^2		6.67		7.222			
p		0.010		0.027			

Ameloblastoma was the main diagnostic finding in both our groups. Odontogenic myxofibroma, osteoblastoma, cemento-ossifying fibroma, odontogenic keratocyst and osteomyelitis were the other diagnostic entities. Statistically, there was no significant difference between the two groups in terms of age ($p = 0.209$), sex ($p = 1$) and diagnosis ($p = 0.279$). Similar findings were observed by Sieg *et al* (2002) who also reported ameloblastoma as 60% among all non-malignant neoplastic cases.[1]

The mean pain on VAS Scale in both Groups depicted significant reduction with time in a similar fashion. The mean pain score was slightly higher in Group II, but statistically there was no significant difference between two Groups ($p > 0.05$). Infection was not seen in patients at 1 week, but at 3rd week it was seen in both groups, and later subsided with proper wound care. Statistically, there was no significant difference between the two groups ($p > 0.05$). Basarir *et al* (2005) & Krieg *et al* (2007) in contradiction to our finding reported 4% and 7% infection rate respectively with the use of non-vascularized fibular grafts.[2,3]

Wound dehiscence was seen in 5 (60%) patients of Group I and (30%) in Group II at different follow up visits, but the difference was not statistically significant ($p = 0.178$). Dehiscence rate of 9% and 16% have been reported with the use of free vascularized iliac crest graft.[4,5] Reychler *et al* (1994) reported more than 11.7% complications in patients with use of free fibula osteocutaneous flap.[6] Later, Peled *et al* (2005) used free fibula flap and reported wound-healing disturbances in 30% cases.[7] In confirmation to our results, 100% success rate has been reported with the use of free vascularized fibula flap.[8,9] Baj *et al* (2003) reported "nil" donor site complication with use of iliac crest free flap.[10] Donor site complications range from 25% to 25.9%.[11,12]

Function improvement was initially seen in 1 (10%) patients in Group I and 2 (20%) of Group II, which rose to 60% and then 100% by 12th week in both groups. Cheung *et al* (1994)[13] reported 75% with vascularized fibular flap and Krieg *et al* (2007)[3] as 80% with non-vascularized fibular bone graft. 100% improvement with fibula free flap in corroboration to our results has been reported by Cuellar *et al* (2006).[14] Vu *et al* (2008) reported better functional results of mandibular reconstruction with iliac crest compared to fibular bone graft.[15] Esthetic improvement was found in all patients (100%) in both groups by 6 months as seen in other studies too.[8,10,14]

A significant positive association between length of defect and complications was noticed. The mean length of defect among those with presence of any complication was 9.8 as compared to 7.0 among those without any complication ($p = 0.012$), implying that patients with larger defects had higher probability of complications. Similar results were reported with use of free vascularized fibular flap in mandibular defects requiring more than 6 cm of bone graft.[6]

Our results indicate that reconstruction using non-vascularized fibular grafts is a simple, inexpensive and quick procedure which does not require extensive training or a large number of operative personnel. The results are comparable to those reported with vascularized grafts. The disadvantage may be that they require somewhat longer time to unite with normal bone, but under favorable conditions this difference does not seem to be important. The advantages include a shorter operative time and lower morbidity at the donor site. The resected part of the fibula may be regenerated completely or in part from the periosteum, especially in younger patients. Non-vascularized fibular and iliac crest grafts can be good alternative to vascularized grafts especially where there is a good cover with soft tissue and good blood supply.

CONCLUSION

Non-vascularized fibular grafts are a useful alternative to non-vascularized iliac crest grafts and can be successfully used for mandibular reconstruction.

CONFLICTS OF INTEREST

All authors have none to declare.

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